Appendix H8

GIS Data Compilation, Mapping, and Analyses

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Appendix H8

H8-1 GIS DATA COMPILATION, MAPPING, AND ANALYSES

The overall objectives of the Operable Unit (OU) 10-04 Ecological Risk Assessment (ERA) include the determination and documentation of adverse effects to ecological receptors on an Idaho National Engineering and Environmental Laboratory (INEEL)-wide scale. To support such an evaluation, a database containing spatial data specific to the INEEL has been constructed. The database contents have been incorporated with geographical information system (GIS) and ARC/INFO analytical tools to support mapping ecological resources with respect to areas of potential contaminant exposure. Interpretive maps have been produced and analyses have been conducted for the distribution of INEEL vegetation and several wildlife species.

H8-1.1 GIS Data Compilation

The general data types required for characterizing and interpreting the spatial relationship of ecological receptors to sources and areas of contamination include the following:

- Contaminant extent and concentration
- Location and extent of habitat for species of interest
- Species distribution (which areas of the INEEL are used and/or inhabited).

Isopleths were produced using air modeling to delineate contaminant extent and concentrations. These isopleths were used to identify the spatial boundaries of assessment areas in which ecological receptors are potentially exposed.

Because detailed habitat models and data were not available for most species, vegetation types were used as a surrogate for general habitat features. The INEEL vegetation map (Kramber et al. 1992) was used as the base data set for OU 10-04 GIS analyses. A description of INEEL vegetation communities, including a vegetation map, can be found in Anderson et al. 1996.

An ORACLE database has been constructed to house GIS distribution data for INEEL species. The database design is presented in Appendix A. Sources from which data were extracted are described in Appendix B. The contents compiled to support GIS mapping and analysis of species distribution are discussed in Appendix C.

GIS analyses incorporating these data sets was applied to (1) identify wildlife and vegetation resources located within contaminated areas, and (2) estimate the proportion of INEEL resources potentially impacted by exposure to areas of contamination. GIS analyses have been conducted and are presented in the following sections.

H8-1.2 GIS Mapping

GIS interpretive maps to support evaluation of individual and population level risks have been developed using the following three step process: (1) delineation of contaminant spatial extent (Figure 1) for the OU 10-04 ERA was overlaid on the INEEL vegetation map to identify habitat composition (Table 1) inside the isopleths, (2) distribution data sets were overlaid on the INEEL vegetation map to draw habitat associations for individual species, and (3) distribution data were evaluated in relation to

vegetation and contaminant isopleths to determine which receptors/resources occur in or are proximate to the areas of contamination.

The distribution data sets for some species can also be used in conjunction with finalized contaminant extent and concentration data to estimate and interpret contaminant-specific risk indicated by the ERA exposure modeling.

In addition to these data sets, several related data sets have been compiled to support this analysis. All data compiled to support OU 10-04 GIS analyses are described in Appendix A. Appendix D contains interpretive maps constructed using these data sets.

H8-1.3 GIS Analysis and Risk Characterization

GIS analytical tools can be used to estimate the portion of each species population exposed based on vegetation/habitat associations and the assumption that all areas of habitat are equally used. Of the available habitat, the portion of total INEEL habitat found in assessment areas encompassing each Waste Area Group (WAG) have been calculated (Table 1)

Species distribution data sets (described in Appendix A) were combined with the GIS vegetation data set to identify general distribution patterns and associated sightings and/or telemetry data with primary vegetation cover types. For example, GIS analyses have been conducted for six species that are generally representative of ecological resources, as well as threatened and endangered (T/E) species and other species of concern to be evaluated in the ERA. They include the following:

- Mule deer
- Burrowing owl
- Ferruginous hawk
- Loggerhead shrike
- Elk
- Pygmy rabbit.

The results of these analyses are summarized in Table 2.

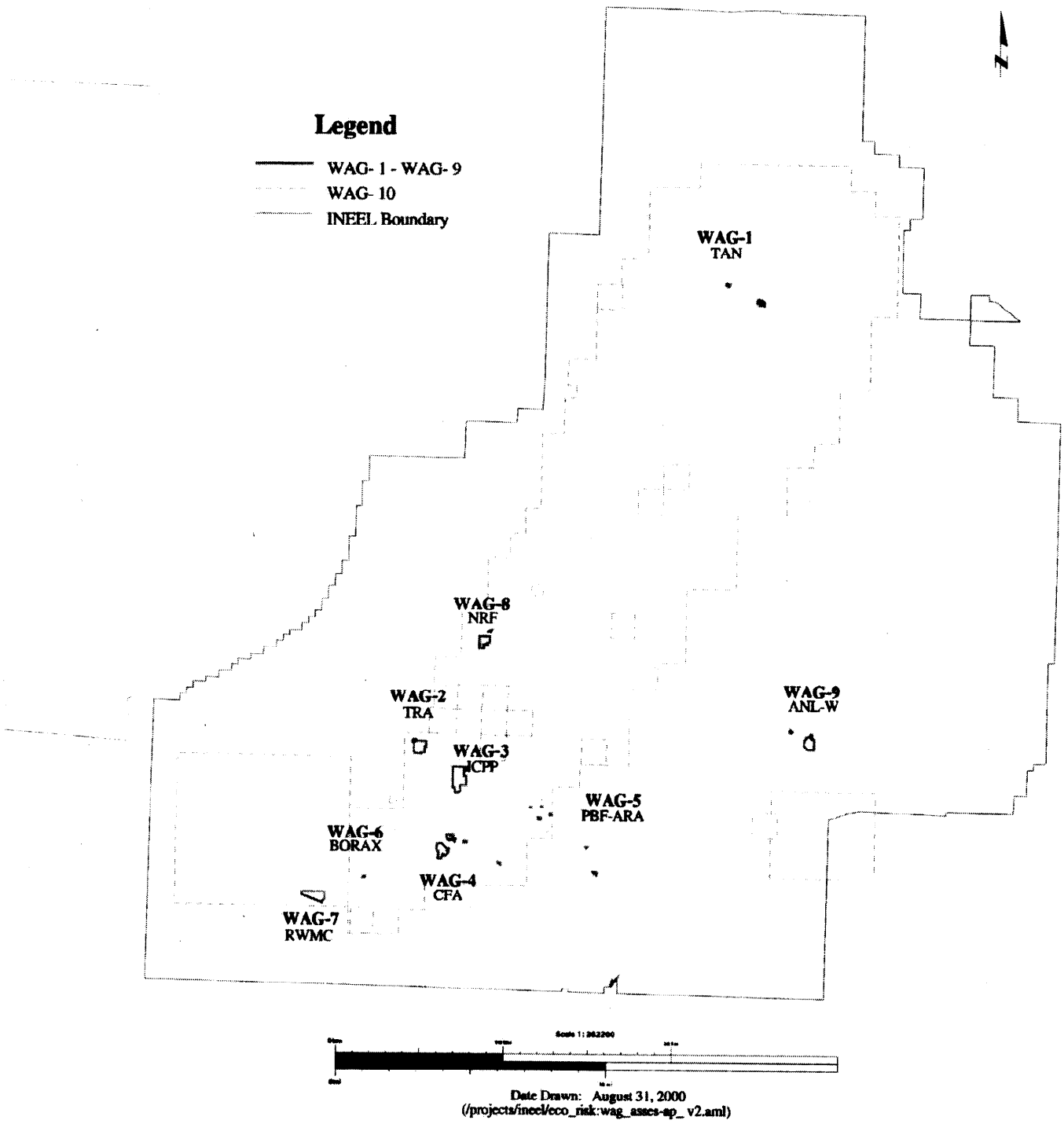

Figure 11. Delineation of Contaminant Spatial Extent.

Table 11. Summary of habitat across the INEEL and within final OU 10-04 assessment areas.

Vegetation Classes	INEEL	%INEEL	WAG 1	WAG 2	WAG 3	WAG 4	WAG 5	WAG 6	WAG 7	WAG 8	WAG 9
Juniper Woodlands	1,575.12	0.68	0.00	0.21	0.11	0.29	0.01	0.00	0.26	0.00	0.00
Basin Wildrye	713.10	0.31	0.00	0.00	0.44	0.76	0.27	0.00	0.00	0.00	1.47
Steppe	2,874.88	1.25	0.22	7.50	20.12	7.61	0.78	0.00	0.00	2.71	3.73
Grassland	11,106.84	4.82	6.90	27.18	104.29	53.98	2.57	0.07	1.63	16.74	10.12
Sagebrush-Steppe off lava	85,892.43	37.24	7.16	219.04	501.59	258.10	21.76	7.94	333.17	302.88	184.79
Sagebrush-Steppe on Lava	90,366.28	39.18	0.01	293.15	581.14	297.74	67.42	7.36	222.01	53.98	273.59
Sagebrush-Winterfat	9,208.03	3.99	14.63	2.49	3.28	6.57	0.37	0.44	43.02	14.55	7.77
Salt desert shrub	7,183.58	3.11	65.02	0.00	0.07	2.15	0.30	0.05	9.76	0.00	4.50
Sagebrush-rabbitbrush	14,291.96	6.20	12.62	0.26	7.53	1.46	0.10	0.09	5.50	9.69	5.65
Sage, low-sage, rabbitbrush on lava	1,531.13	0.66	0.00	1.16	1.43	1.20	0.67	0.06	0.27	0.00	0.14
Wetlands	241.02	0.10	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Playa-bareground/ gravel-borrow pits	1,769.81	0.77	30.49	6.49	7.60	60.82	0.84	0.18	26.65	22.92	13.16
Lava	1,579.24	0.68	0.00	0.00	0.00	0.12	0.28	0.02	0.67	0.00	0.57
Old fields, disturbed areas, seedings	1,187.82	0.52	0.22	0.53	0.00	0.41	0.03	0.00	1.48	2.11	1.22
Steppe-Small Sagebrush	332.95	0.14	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shadow	80.26	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Agricultural lands	249.92	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Facilities[a]	433.21	0.19	138.60	558.00	1,227.60	691.20	95.40	16.20	644.40	425.59	506.70
INEEL total (ha)[b]	**230,617.59**	**100.00**	11,410.31	10,095.58	31,507.52	11,399.48	18,633.47	1,573.86	4,924.49	1,698.81	6,884.30
% of INEEL total	—	—	6E-04	2.4E-03	5E-03	3E-03	4E-04	7E-05	3E-03	2E-03	2E-03

a. Total area disturbed based on sampling and air modeling.
b. Total area encompassed by each WAG before site areas were reduced to the facility boundaries based on sampling and air modeling.
c. Area of vegetation classes was calculated assuming facility areas were nonexistent and disturbed areas were original vegetation composition.

H8-1.1.1 Interpretation of Analyses

The breeding bird survey (BBS) is the primary source of avian distribution data for the INEEL. The only two T/E species recorded on the INEEL, and the majority of other species of concern, are birds. The INEEL-wide distribution for those species can be spatially assessed using BBS data and specific vegetation cover class or classes identified on the INEEL vegetation map. Because no accurate measurements for BBS survey locations existed at the time of this analysis, the vegetation class associated with bird sightings has been approximated and may or may not accurately reflect vegetation type at individual stops.

The analysis for burrowing owls also combines Environmental Science and Research Foundation (ESRF) data and BBS surveys. GIS data overlaid on the vegetation map (Figure D-1 of Attachment H8) indicate that sagebrush habitats are most often associated with owl locations. Although prime habitat is described as grasslands (ESRF annual report 1997), distribution data shows no clear pattern or limitations across the INEEL. This suggests that areas of habitat used by burrowing owls may be too small to be differentiated on the current scale of the vegetation map. Therefore, it must be assumed that an area is as likely to be used as any other. The results of this analysis are unlikely to change with reanalysis using corrected Global Positioning System (GPS) data for BBS route stops.

The GIS analysis for the ferruginous hawk (Figure D-2 of Attachment H8) includes a combination of BBS data and nest location data (undocumented). Distribution data shows no clear pattern or limitations across the INEEL, so it must be assumed that one area is as likely to be used as any other. Separate analyses using hawk-nesting data indicate that no ferruginous hawk nesting sites have been recorded in the assessment areas (as they are currently mapped). The results of this analysis are unlikely to change with reanalysis using corrected GPS data for BBS route stops.

The GIS analysis for loggerhead shrikes (Figure D-3 of Attachment H8) indicates that, as expected, this bird is associated with sagebrush vegetation types across the INEEL. In addition, shrikes are also regularly recorded along facility routes. Distribution data show no clear pattern or limitations across the INEEL, so it must be assumed that one area is as likely to be used as any other. The results of this analysis are unlikely to change with reanalysis using corrected GPS data for BBS route stops.

The GIS overlay for elk (Figure D-4 of Attachment H8) is based on telemetry data for several radio-collared individuals. The data sets indicate that the radio-collared animals roamed east to the INEEL boundary, no further west than the central portion of the INEEL and no further north than the midsection of the INEEL. This may be interpreted as a restriction to a general home range for the individuals that does not include any portion of the OU 10-04 assessment areas. Based on habits displayed, elk may be eliminated as receptors to be evaluated in the assessment.

The GIS overlays for mule deer (Figure D-5 of Attachment H8) indicate that the habitat most frequented by radio-collared individuals (telemetry data) is sagebrush steppe on and off lava. No data have been collected for mule deer in the northern portion of the INEEL; therefore, habitat is estimated only for the southern half of the INEEL. Although mule deer activity appears high in the areas of contamination associated with WAGs 4 and 5, the telemetry data may represent the movement of only one or two individuals. These data are a portion of a study still in progress (ESRF 1999).

The GIS analysis for the pygmy rabbit (Figure D-6 of Attachment H8) incorporates the only habitat model developed and tested for species on the INEEL (a preliminary model for locating snake hibernacula was also tested). In addition to vegetation type, the habitat model for the pygmy rabbit also incorporates topographical and aspect data to identify areas with highest probability for supporting pygmy

rabbits (ESRF 1998). Although unsupported by field observation, pygmy rabbits must be assumed to inhabit all areas of potential habitat with equal likelihood.

H8-1.1.2 Data Limitations and Assumptions

Individual data sets compiled for the OU 10-04 ERA analyses have specific limitations that are presented in Appendix A. Some general limitations pertinent to the level and quality of assessment that can be supported by these data sets include the following:

- INEEL ecological data are not generally available in electronic or GIS compatible format. Most data sets created thus far have required data entry and/or alteration to create computer compatible files. Appendix A summarizes what has been done. Future data compilation would require substantial effort.

- Few long-term data sets exist (i.e., BBS, jackrabbit, raptor counts). Most data sets can be used to produce only rough estimates of resident or cyclic populations for many species.

- Census data are limited to a few species and the populations and activities of large animals are more often surveyed and more accurately estimated than those of small animals. Accurate location coordinates (i.e., telemetry or GPS data) are not available for most data sets.

- INEEL-wide distribution data have not been collected for most species. Validated habitat models are also not available for most species. Distributions for most species of interest must, therefore, be based primarily on vegetation associations and range maps of varying scale and accuracy. Evaluations based on habitat associations may have additional limitations and restrictions.

- INEEL GIS base maps (i.e., vegetation and soils) have not been assessed for accuracy and only limited ground truthing has been conducted.

H8-1.4 References

Anderson, J. E, K. T. Ruppel, J. M. Glennon, K. E. Holte, and R. C. Rope, 1996, *Plant communities, Ethnoecology, and Flora of the Idaho National Engineering Laboratory*, ESRF-005, Environmental Science and Research Foundation, Idaho Falls, ID.

DOE-ID, 1999, *Work Plan for Waste Area Groups 6 and 10 Operable Unit 10-04 Comprehensive Remedial Investigation/Feasibility Study*, DOE/ID-10554, Rev. 0, April.

Kramber, W. J., et al., March 1992, "Producing a Vegetation Map of the Idaho National Engineering Laboratory Using LANDSAT Thematic Mapper Data," *Proceedings of ASPRS 1992 Annual Meeting*, Albuquerque, New Mexico.

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VanHorn, R. L., N. L. Hampton, and R. C. Morris, April 1995, *Guidance Manual for Conducting Screening Level Ecological Risk Assessment at the INEL*, INEL-95/0190, Lockheed Martin Idaho Technologies Company.

Weigmann, D. L. and R. D. Blew, editors, 1999, *Annual Technical Report to DOE-ID: Calendar Year 1998*, ESRF-033, Environmental Science and Research Foundation, Idaho Falls, ID.

Attachment 1

ORACLE and ARCVIEW Databases to Support OU 10-04 GIS Mapping and Analyses

Attachment 1

ORACLE and ARCVIEW Databases to Support OU 10-04 GIS Mapping and Analyses

Data compiled to support OU 10-04 GIS spatial analyses are housed in ORACLE and INFO (ARC/INFO) data files on the Environmental Restoration Information System (ERIS) system. The database was constructed in two basic steps:

1. INEEL-specific wildlife studies and existing data sets were reviewed and those studies and/or data sets associated with wildlife distribution, density or populations were identified. The search was generally focused on a selected group of wildlife species and pertinent data were compiled in spreadsheets. The literature search is documented in a report by Perry and Chellis (1996) (Appendix B).

2. Data were extracted from the spreadsheets and converted to ORACLE and INFO data tables to allow GIS interpretation. Database files designed to support analyses using distribution data (e.g., species and documentation cross-referencing) have been constructed, but spreadsheet information has not been transferred to ORACLE files. Data sets including wildlife distribution information for several other species already reside in the GIS system in a different format. These data sets are also available for analysis, and are housed independently of the data sets described here. Those data sets are described in Section A-5.

Individual data sets are linked through a primary data set containing all INEEL species taxonomic and common names. The database file formats are described in the following sections. The NOT NULL value(s) in each file indicate data fields that are the primary sort and file linkage keys. Data set contents are discussed further in Appendix C.

A1-1. INEEL SPECIES LIST

The INEEL species list (ANIMAL_SPECIES) contains names (common and taxonomic) and unique codes for animals found on the INEEL (Table A-1). The list of species contained in the file was taken from Reynolds et al. (1986).

Table A-11. File format for ANIMAL_SPECIES.

Name	Null?	Type
CLASS		VARCHAR2(15)
A_ORDER		VARCHAR2(30)
FAMILY		VARCHAR2(30)
TAXOMONIC_NAME		VARCHAR2(60)
TAX_CODE	NOT NULL	VARCHAR2(10)
COMMON_NAME		VARCHAR2(60)
COMM_CODE		VARCHAR2(10)

Parameters include full text entries for Class, Order, Family, and both Taxonomic and Common Names for each species found at the INEEL (reference). Taxonomic and Common name codes (TAX_CODE and COMM_CODE) are unique 4-character codes generated to serve as a shorthand

reference or search key for individual species. The data for this file has been generated in spreadsheet format, but the ORACLE table has not been populated.

A1-2. SPECIES DISTRIBUTON DATA

Data associated with distribution and census of individual wildlife species are contained in the ERA_STUDY_INFO file. The format describing contents of the file is given in Table A-2.

Table A1-2. File format for ERA_STUDY_INFO.

Name	Null?	Type
REC_NO	NOT NULL	NUMBER
COMMON_NAME		VARCHAR2(60)
SPECIES_CODE		VARCHAR2(6)
KEY	NOT NULL	NUMBER
STUDY_DATE		VARCHAR2(30)
NUM_SITINGS		NUMBER
GROUP_CODE		VARCHAR2(10)
LATITUDE		VARCHAR2(12)
LONGITUDE		VARCHAR2(12)
EASTING		NUMBER
NORTHING		NUMBER
HOW_PROVIDED		VARCHAR2(60)
HABITAT		VARCHAR2(1000)
VEG_TYPE		VARCHAR2(15)
UNCERTAIN_INFO		VARCHAR2(400)
MISC_INFO		VARCHAR2(400)
NLAT		NUMBER
NLONG		NUMBER

The record numbering field (REC_NO) was generated as a unique sequential number corresponding to individual data entries. Full text entries are included for species common and taxonomic names (fields COMMON_NAME and SPECIES_CODE).

The KEY field contains information regarding the source publication(s) from which distribution/abundance data were extracted. The files within the database are linked by a unique number provided for individual citations contained in the bibliography entitled "Radioecology and Ecology Publications of the Idaho National Engineering Laboratory: 1974–1994" (Morris 1995). This publication contains a list of reference material associated with studies done on the INEEL (Idaho National Engineering and Environmental Laboratory). The key entry for sources of information for this database corresponds to the publication number in Morris (1994).

The GROUP_CODE field contains a code to identify the gender of animals captured, counted or otherwise censused: males (M) and females (F). In cases where the total number of animals is provided, but gender information is not included, the number of animals was recorded as unknown (UNKNOWN). In cases where counts involving juveniles were provided (and gender also unspecified), the data were also recorded as unknown.

The location of the study, when provided, was entered as latitude and longitude coordinates (fields LAT and LONGITUDE). The column "How Provided" refers to how the location of the study site was

identified in the article. In most cases, a general descriptive location of the distance from a landmark or from one of the facilities is given. Map coordinates (i.e., township and range designated in the database as T&R) were converted and entered as latitude and longitude coordinates. These are in turn converted to universal transverse mercator (UTM) coordinates for mapping purposes (fields NORTHING and EASTING).

The timeframe in which the studies were conducted is recorded in the STUDY_DATE field. Some studies were specific to the day while others gave a general time frame (e.g., the study was conducted during the summer of 1991). Dates in which data were collected are entered as month or year, or ranges of month/year combinations. Data are currently uncoded and do not reflect standard date format (e.g., mm/dd/yy).

Habitat information recorded in the file (HABITAT) includes vegetation and landform descriptions associated with the study site. In some cases, the level of detail includes plant species, but generally only community type is given. Where possible, the information was used to derive an INEEL vegetation map class associated with the study area (field VEG_CLASS). The vegetation class assignment is subjective and not based on detailed data collected at a precise location. Information describing the study area and location were used to make a best estimate as to the vegetation class. The contents of the VEG_CLASS field is coded as follows: G = grasslands, L = lava, SS1 = sagebrush off-lava, SS2 = sagebrush on-lava, SW = sage/brush winterfat.

Two fields supply support information associated with the distribution data. The fields were added to allow entry of comments or other text related to the study (UNCERTAIN_INFO). For example, information to clarify sampling uncertainty, or relevant information that could help in later calculations for abundance and density, or document the size of the study site, may be useful in calculating a number of organisms per unit area. If no pertinent information was identified, the fields were left blank.

A1-3. SOURCE REFERENCE DATA

The document reference (DOC_REFERENCE) file contains information regarding the source publication(s) from which distribution data were extracted (Table A-3). This file could ultimately be back-linked to the ERALIT database (VanHorn et al. 1995) through the file KEY, author or title.

Table A1-3. File format for DOC_REFERENCE.

Name	Null?	Type
KEY	NOT NULL	NUMBER
DOC_TITLE		VARCHAR2(1000)
DOC_AUTHOR		VARCHAR2(200)
YEAR????		

The key entry for sources of information for this database corresponds to the publication number in Morris (1995). Full text entries are included for document title (DOC_TITLE) and authors (DOC_AUTHOR). This ORACLE table has not been populated with contents.

A1-4. INEEL BREEDING BIRD SURVEY DATA

The breeding bird survey (BBS) data contains data for most years between 1984 and 1996 (see Table A-4). The original ESRF BBS data files have been edited and recompiled to meet requirements for consistent ORACLE table format.

Table A1-4. File format for BBS.

Name	Null?	Type
ROUTE_NUM	NOT NULL	VARCHAR2(1)
START_TIME		VARCHAR2(5)
STOP_NUM	NOT NULL	NUMBER
SURVEY_DATE		DATE
COMMON_NAME	NOT NULL	VARCHAR2(30)
NUM_SITINGS		NUMBER

Only species common names (COMMON_NAME) are recorded for BBS surveys. The surveys are conducted along preestablished routes, each of which has a unique name and number (ROUTE_NUM). The physical inventory of birds is conducted at "stops" laid out at regular intervals along each route (STOP_NUM). Survey protocols include documentation of the survey start time (START_TIME), date (SURVEY_DATE), common name of birds observed (COMMON_NAME), number of sightings per unique route, stop number and common_name combination (NUM_SITINGS).

A1-5. ADDITIONAL DATA FILES

A file to house animal density by unit area for a given vegetation type has been constructed (ANIMAL_DENS_VEG). The file format is given in Table A-5 and is designed to include coded vegetation class (see species taxonomic code, and the density for each combination). Tax code is linked to species table. No data have been compiled to date.

Table A1-5. File format for ANIMAL_DENS_VEG.

Name	Null?	Type
VEG_TYPE	NOT NULL	VARCHAR2(15)
TAX_CODE	NOT NULL	VARCHAR2(10)
DENSITY		NUMBER

In addition to the files created specifically for this database, several preexisting GIS data sets are also available for inclusion in the OU 10-04 assessment. In some cases, existing data sets have been combined with newer sets (e.g., burrowing owl analysis combines BBS and ESRF data). These data sets contain telemetry or other location data for species including

- Elk (studies by Strohmeyer [1992], and Peek and Comer [ESRF 1999])
- Mule deer (studies by Peek and Beaver [ESRF 1998,1999])

- Bobcat (source unknown)
- Burrowing owl (studies by Fahler [ESRF 1999])
- Sage grouse (lek locations from undocumented sources)
- Ferruginous hawk and other hawk nesting sites (source unknown)
- Sensitive plant species (undocumented).

These data sets are largely undocumented, but are briefly described in Appendix C.

NOTE: Some data sets contain sensitive data (e.g., nesting locations) for important species. In others, the data sources have not been documented, data ownership/copyright is unclear, or contents have not been verified. These data sets can be used as overlays to develop and support interpretive analyses and summaries (i.e., No T/E plant species or sage grouse leks have been recorded in the assessment area). However, these data should also be subject to controlled distribution based on specific consideration of these limitations. A summary of personal contacts and permissions obtained for data included in this file is given in Appendix B.

A1-6. REFERENCES

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